

Watershed Science & Engineering

ERDC Cold Regions Research & Engineering Laboratory



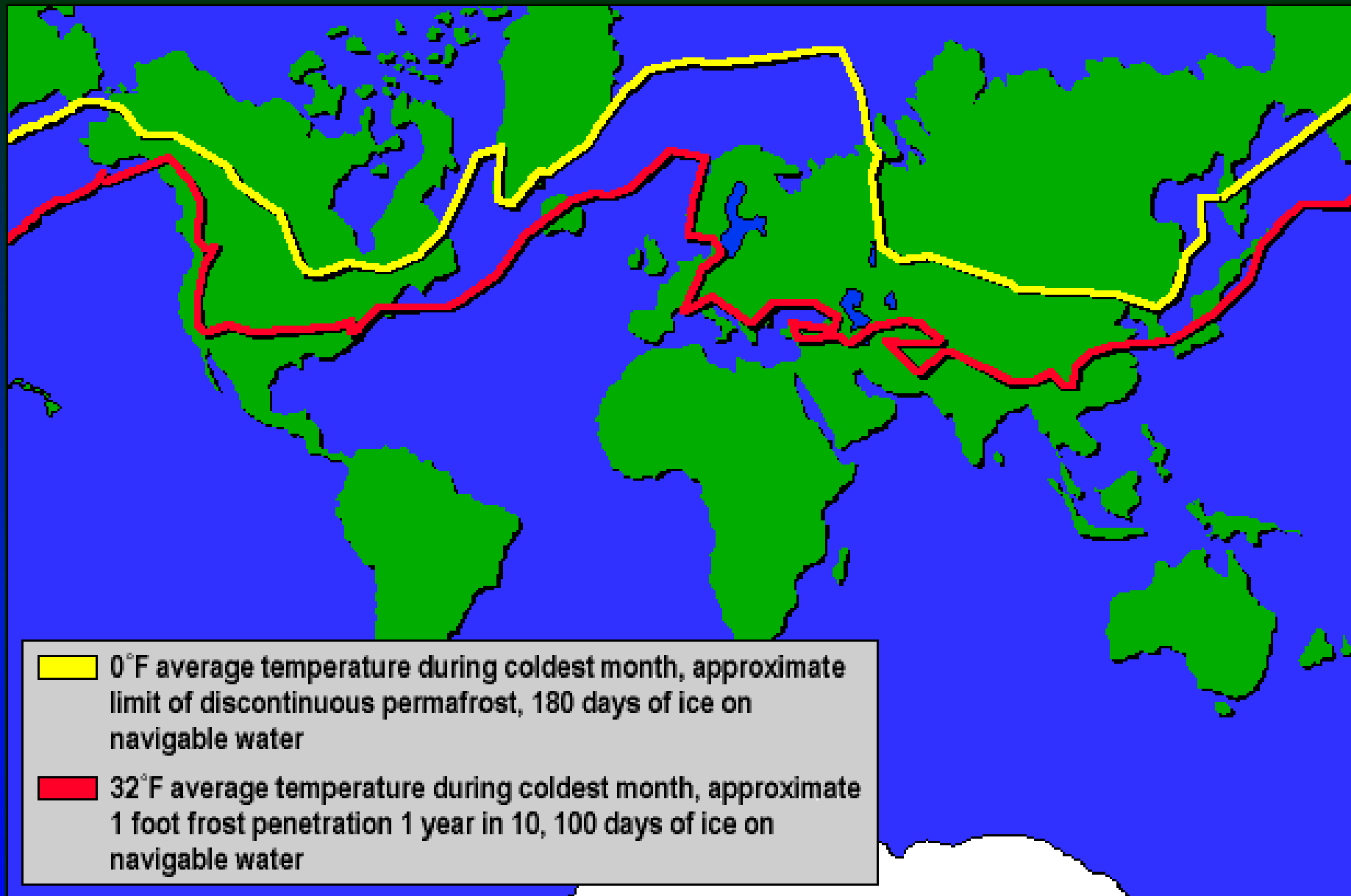
Darryl Calkins

ERDC Technical Director for Geospatial Technologies

ERDC-CRREL Mission Area

- Gain knowledge of cold regions through scientific and engineering research
- Put that knowledge to work for the Corps of Engineers, the Army, the Department of Defense, and the nation
- CRREL is the DoD's only laboratory that addresses the problems and opportunities unique to the world's cold regions





Technical Capabilities in Water Resources

- **Ice Engineering Facility-Temperature Controlled Rooms**

- Physical hydraulic modeling area
- Flume
- Towing tank/test basin

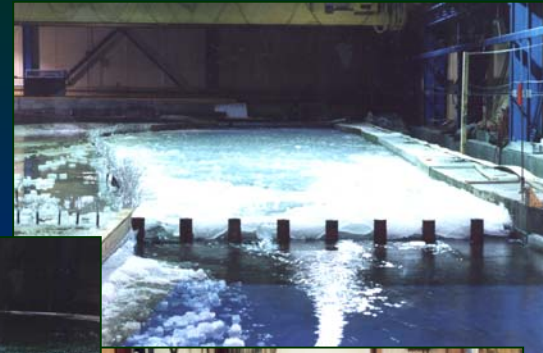
- **Field Sites**

- Sleepers River Research Watershed-VT
- Caribou-Poker Creek Watershed-AK
- CO-WY CLPX regional study areas (1 large, 3 small)

- **Staff**

- Research Hydraulic Engineers
- Hydrologists
- GIS specialists*
- Ecologist
- All other engineering and science disciplines

*GIS staff with Natural Resources Backgrounds



Historical Perspective

- 60's (SIPRE, ACFEL \Rightarrow CRREL in 1961)
 - Science based research
 - Heat transfer characteristics of surface waters
 - Snow & lake ice morphology
- 70's
 - Engineering for winter navigation on the Great Lakes
 - Snowmelt modeling with NOAA (Bulletin 17)
 - Ice Engineering Facility constructed
- 80's
 - Physical hydraulic modeling in IEF cold rooms
 - Initial numerical modeling of ice covers (with HEC)
 - Ice breaker ship model tests (submarines as well)
- 90's
 - RS & GIS in watershed management
 - Advanced numerical modeling techniques
 - Advanced state of the science in snowmelt

Current Technical Activities

Topic

- River Ice
- Hydrology
- Remote Sensing
- Geospatial Technologies

Customer

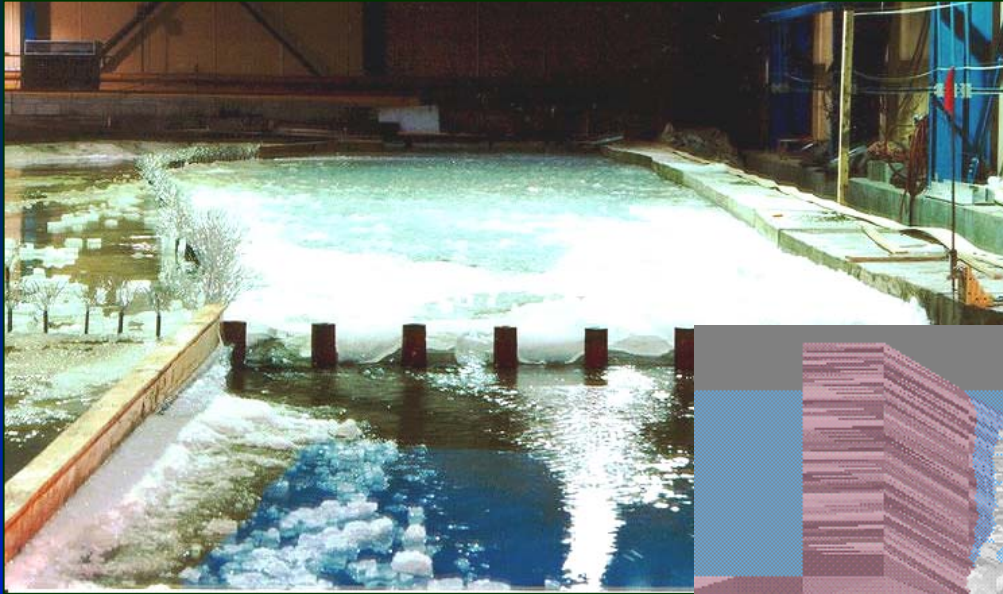
- Districts + CW R&D + EM + others
- Districts + CW R&D + ME + Installations + NASA & NOAA + others
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River Ice Hydraulics

- Numerical & physical modeling of ice processes
- River ice forecasting & ice jam prediction
- Ice mitigation measures
- Winter O&M of Corps structures
- Risk analysis of ice-affected structures
- Effects of ice on stream restoration
- Ice jam emergency response

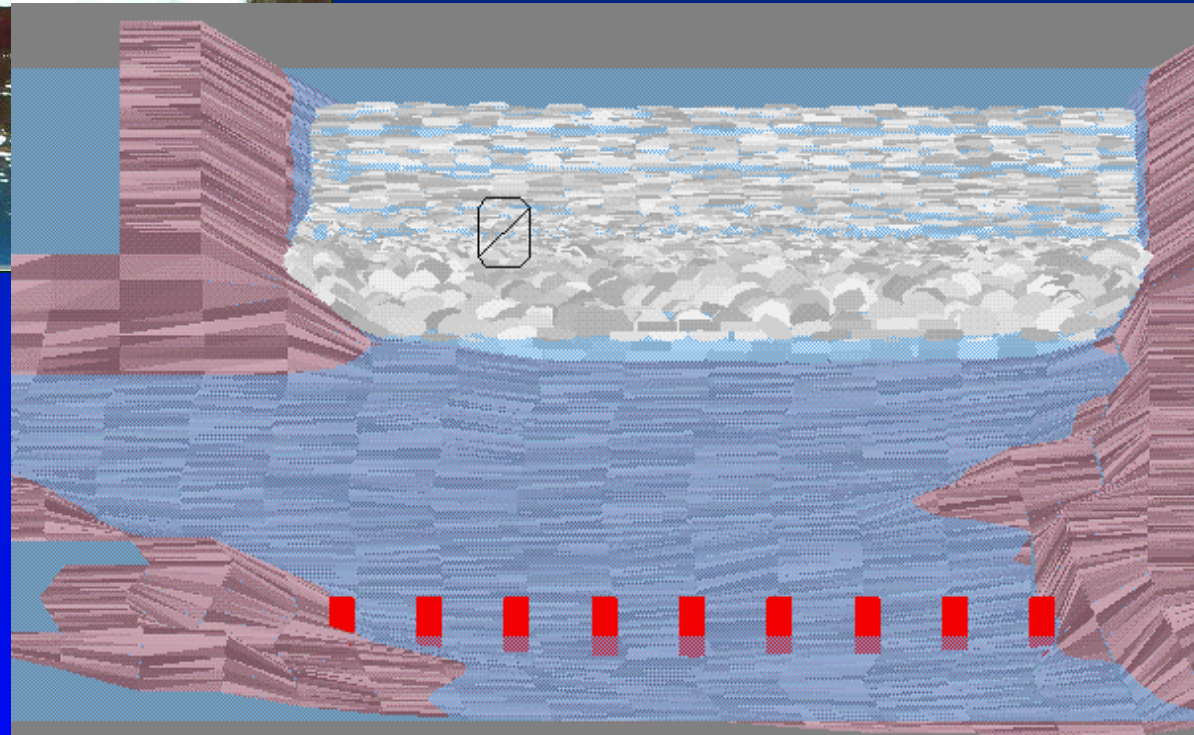


Numerical and physical modeling aid optimized design of ice control structure

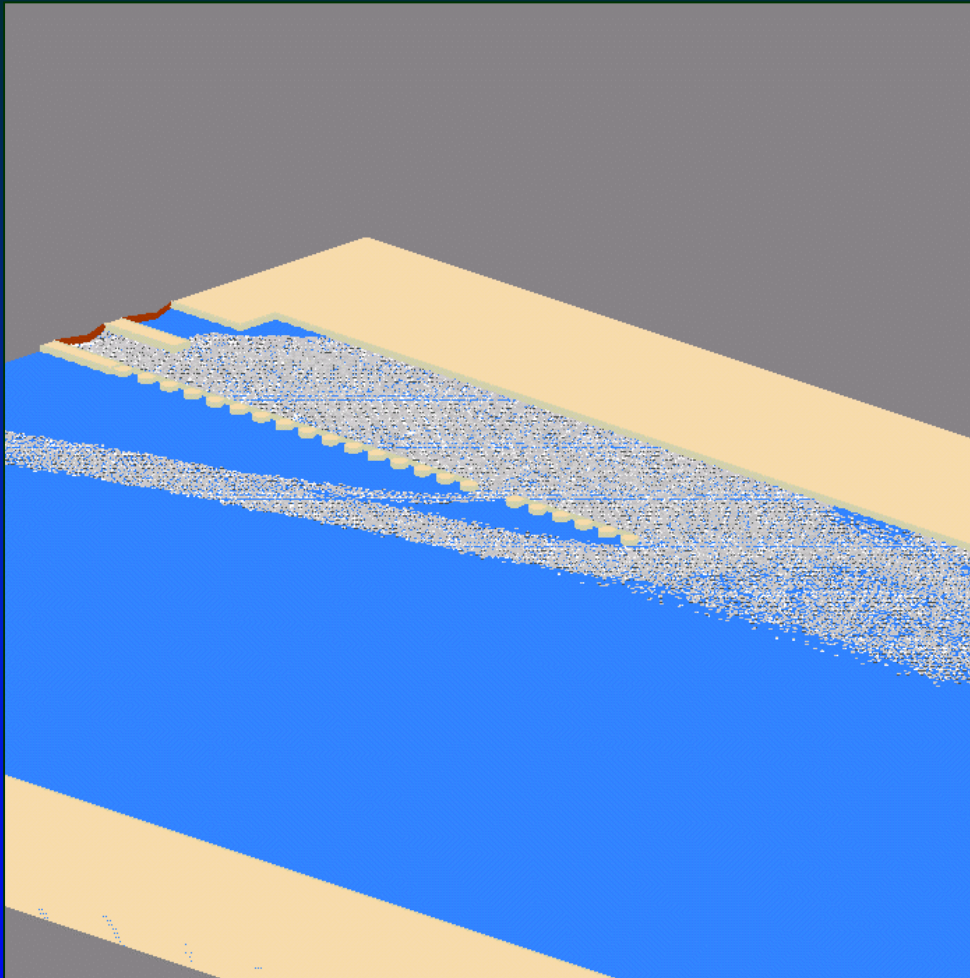


DEM Simulation of Cazenovia Creek Model Study

- Realistic river channel geometry
- Direct comparison of model and simulation stages and forces

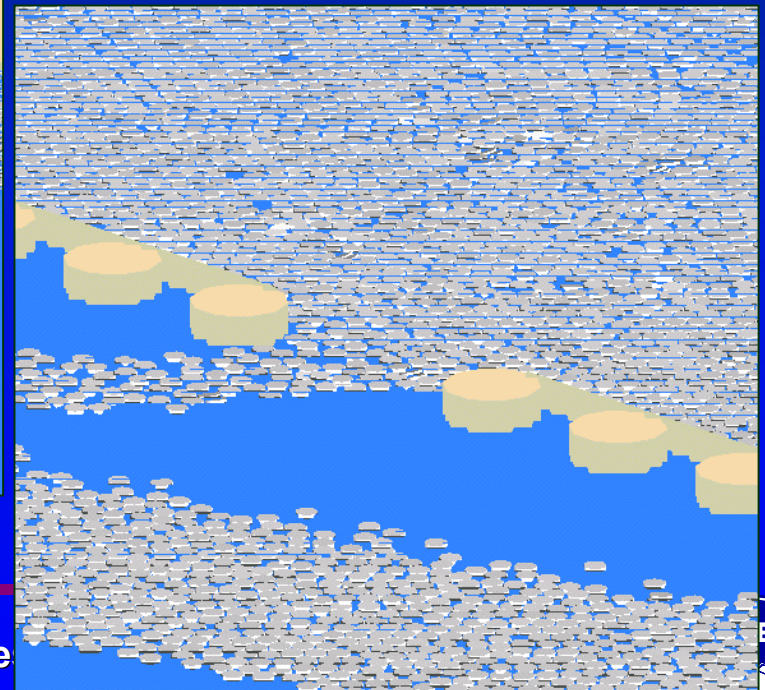


Simulation of ice in lock approach



3D DEM Simulation used
to evaluate ported guard
wall with gap

Water Velocities from
HIVEL2D (Stockstill-CHL)

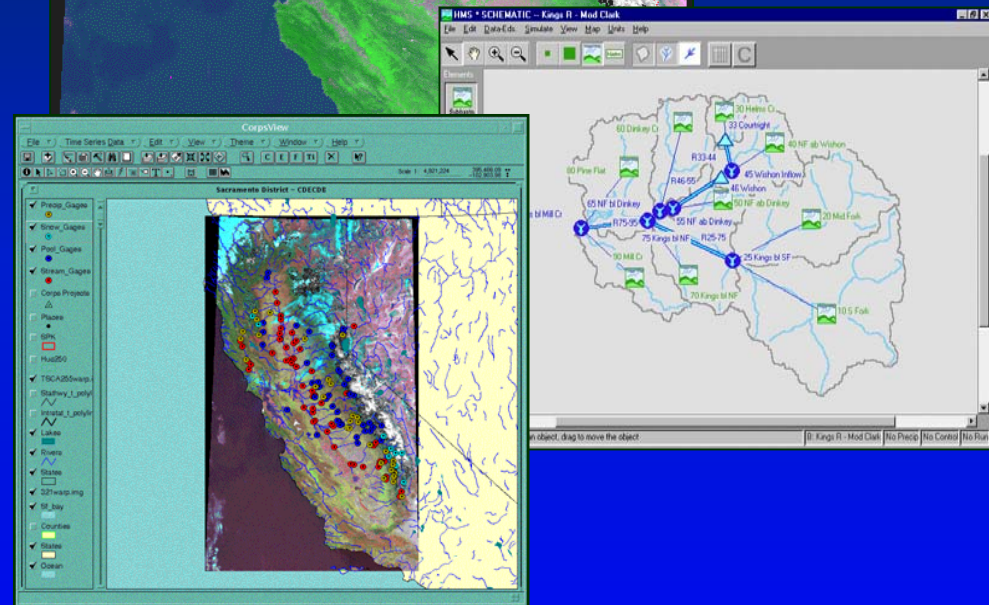
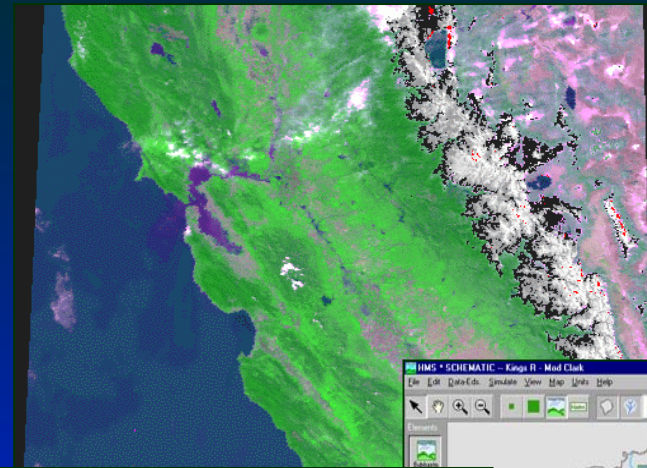


Ice and debris modeling

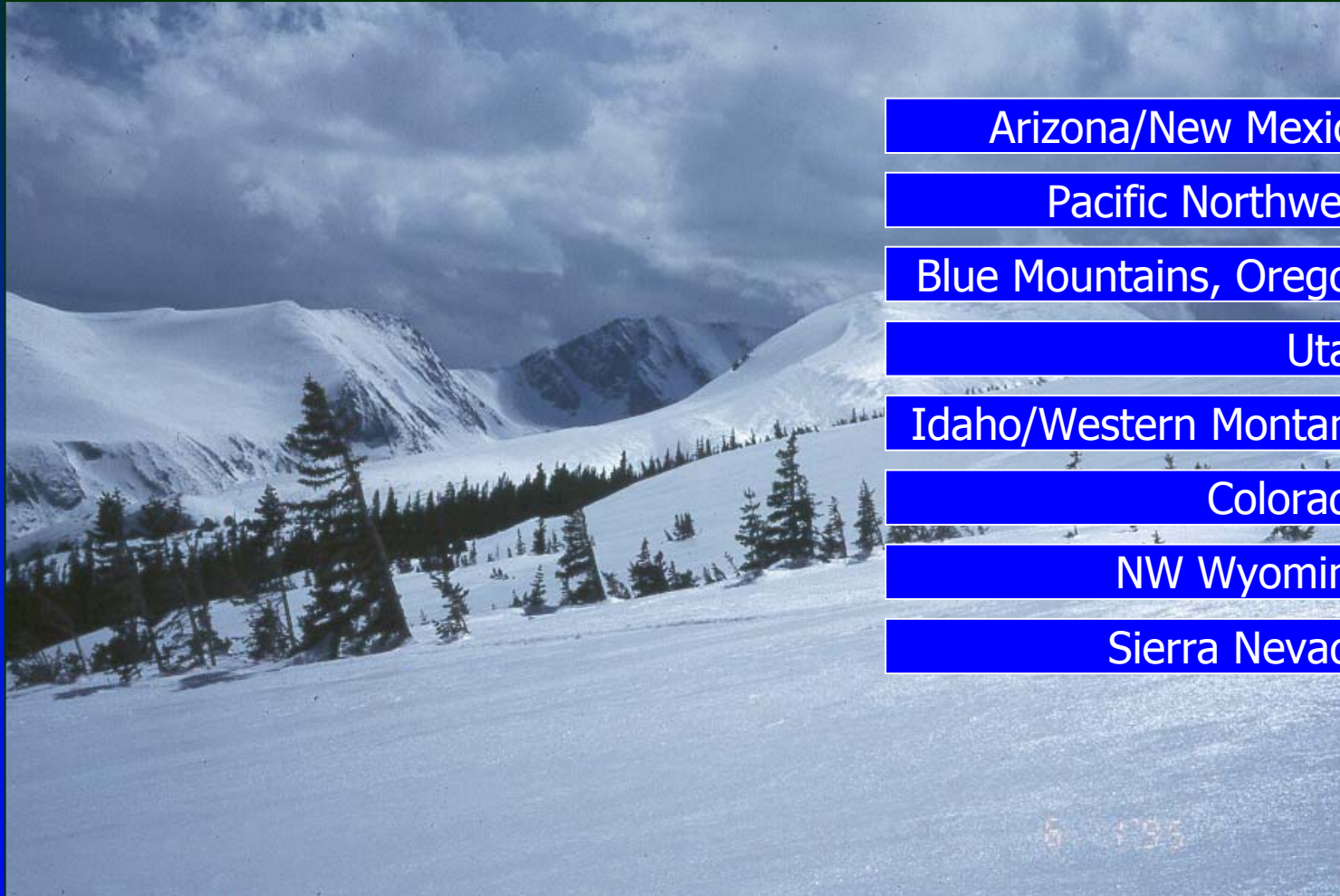
Discrete element model accounts for ice piece motion and forces, 2-D hydrodynamics, currently updated to model various piece size distributions and debris

Hydrology

- Lead for COE research in snowmelt hydrology
- Integrating technologies into civil and military operational systems
 - Add snowmelt capabilities to HEC-HMS (XMS soon)
 - Object-oriented tools for interpolating meteorological parameters
- Lead for science plan and coordinating results for Interagency Cold Land Processes Experiment (CLPX)



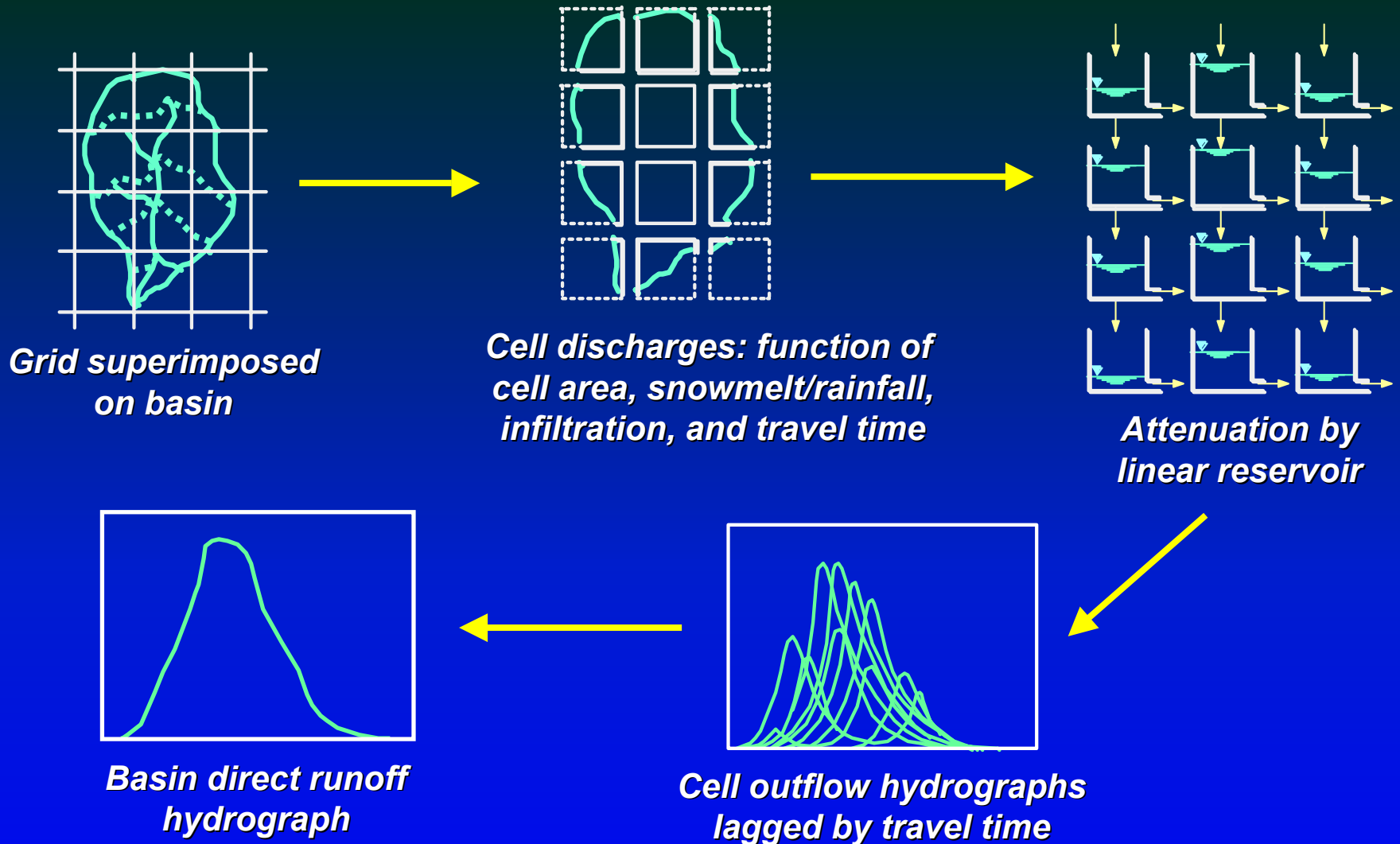
Percentage of Annual Precipitation Derived From Snowfall in Western United States



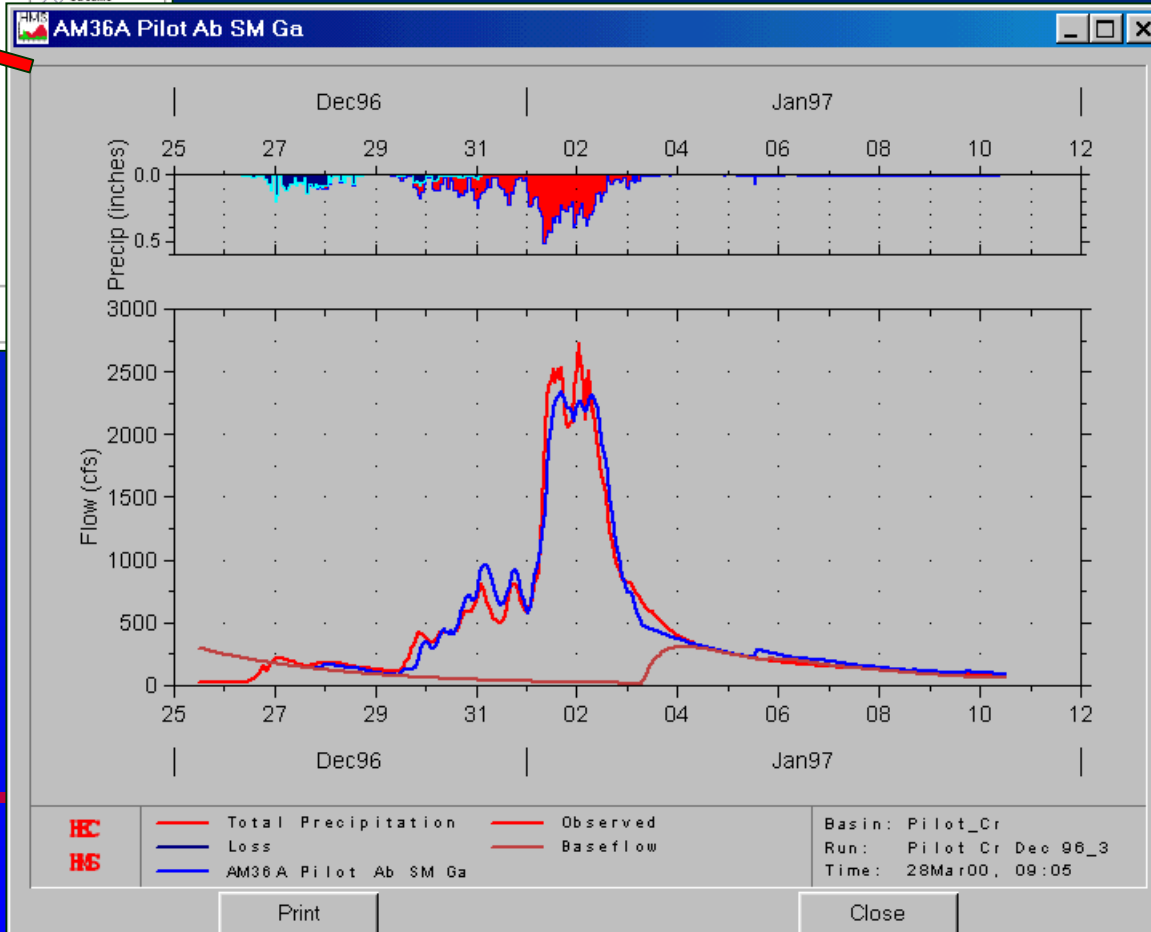
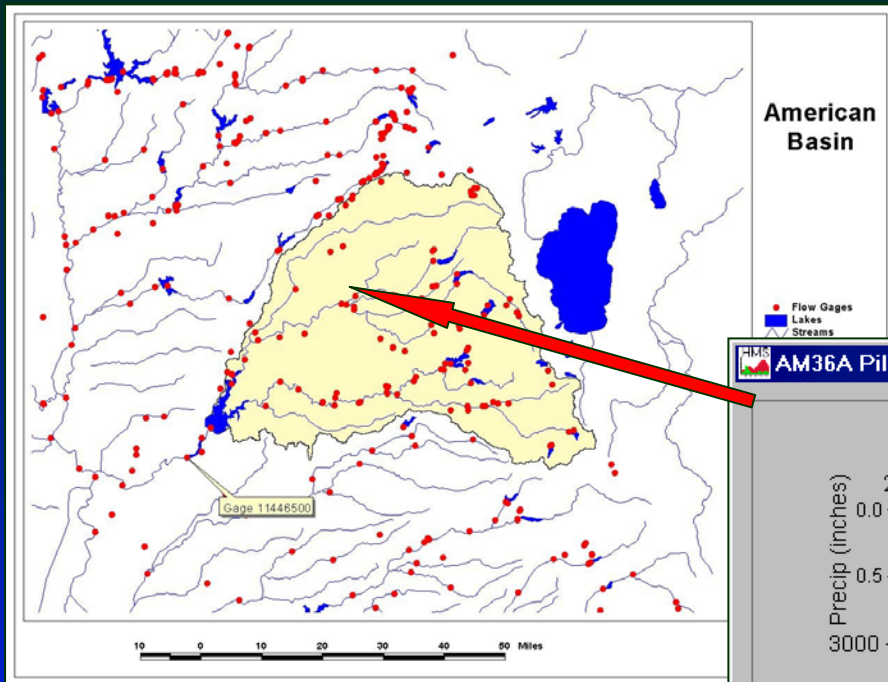
Arizona/New Mexico:	39%
Pacific Northwest:	50%
Blue Mountains, Oregon:	57%
Utah:	60%
Idaho/Western Montana:	62%
Colorado:	63%
NW Wyoming:	64%
Sierra Nevada:	67%

From Serreze et al., *Water Resources Research* 35(7), July 1999

Gridded distributed snow process model (DSPM)

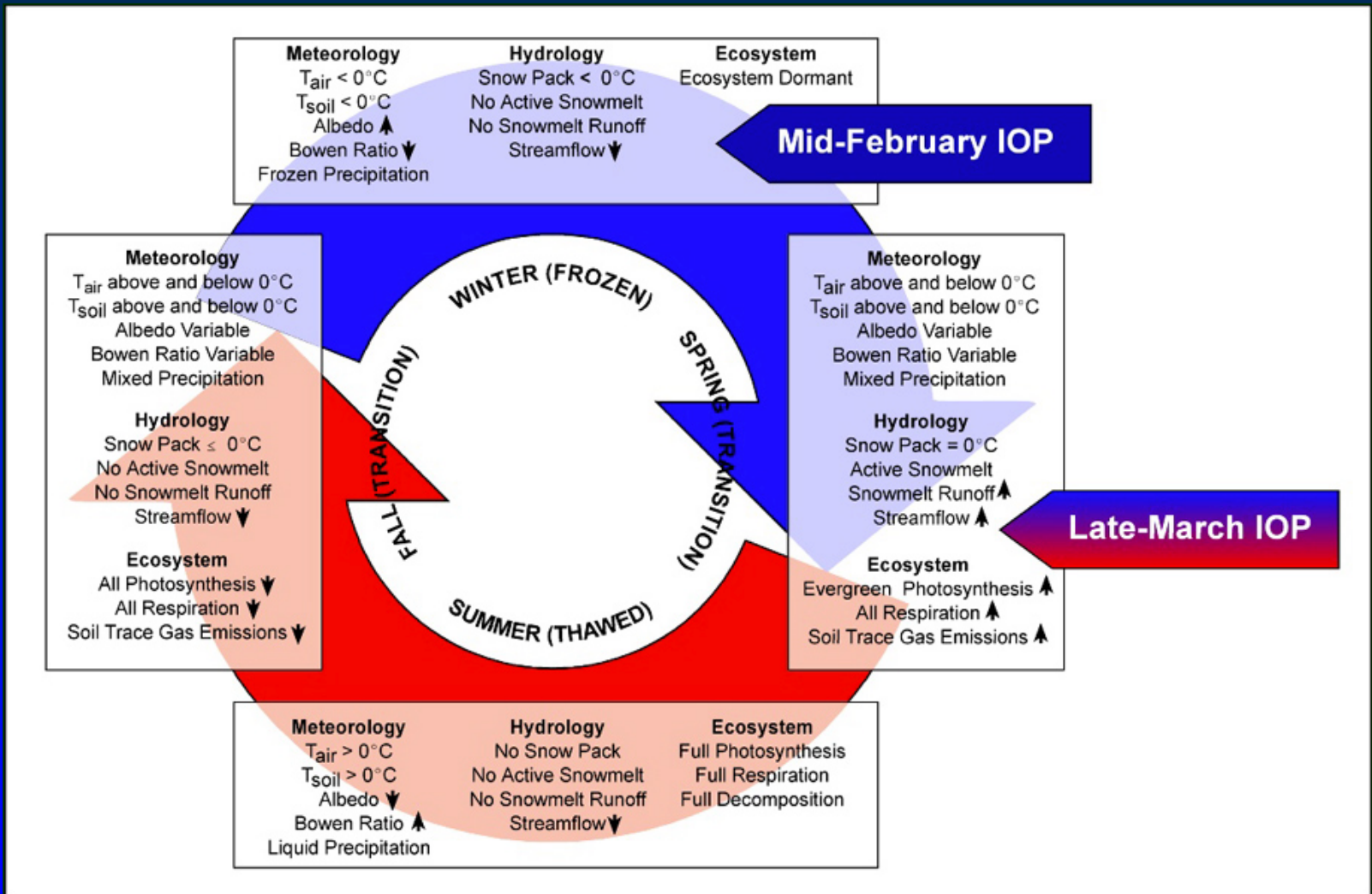


Runoff Routing: HEC-HMS



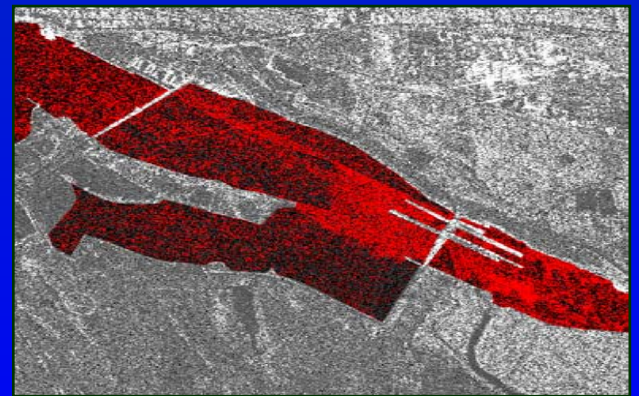
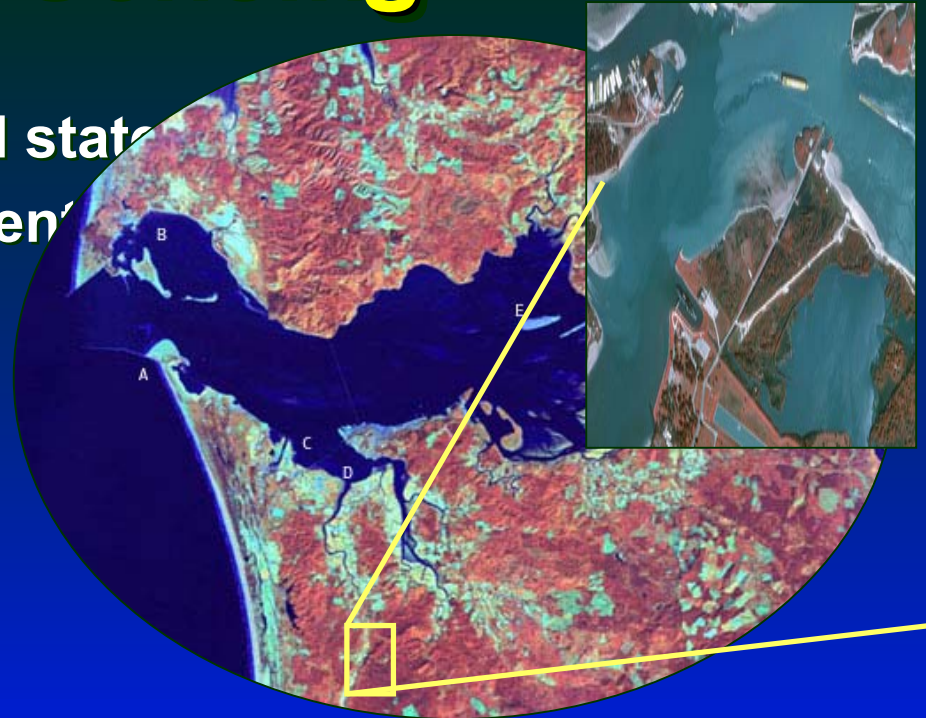
CLPX: NASA, NOAA, ERDC-CRREL, Academia

- microwave remote sensing to measure critical components of the terrestrial cryosphere, including snow pack characteristics and freeze/thaw state of the land surface



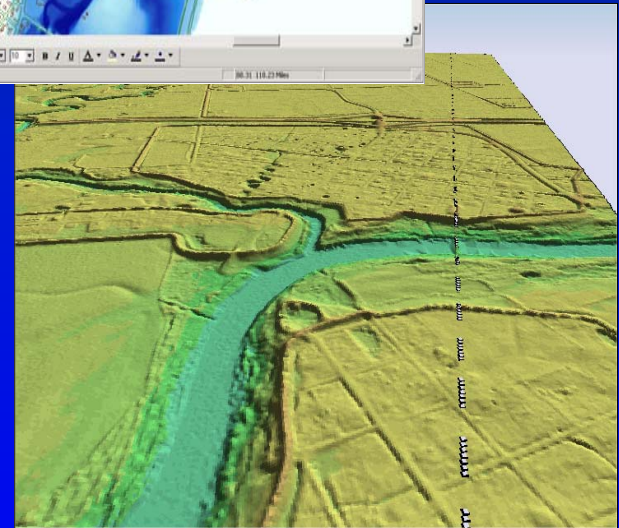
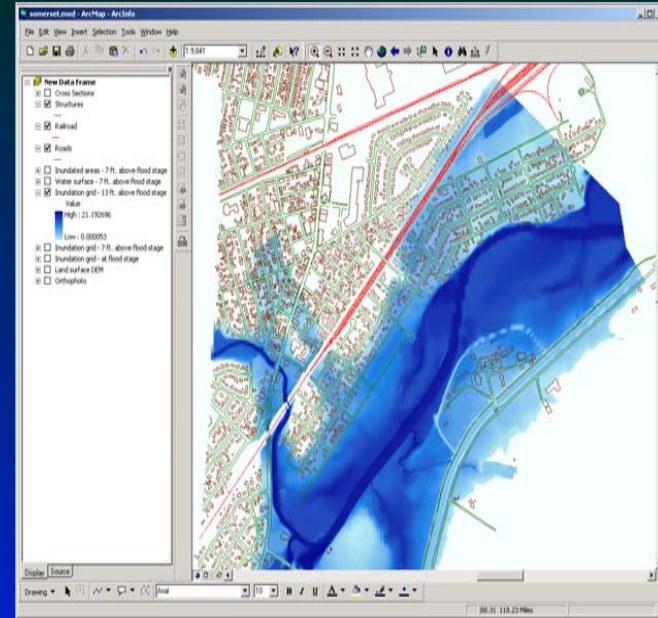
Remote Sensing

- Assessment of snow & ground state
- Cold Land Processes Experiment
- Advanced remote sensing of snow cover
- Operational river ice monitoring using RADARSAT
- Utilization of high resolution imagery
- Integration of RS & evolving technologies in EM
- High resolution LIDAR processing for Civil Works mapping applications

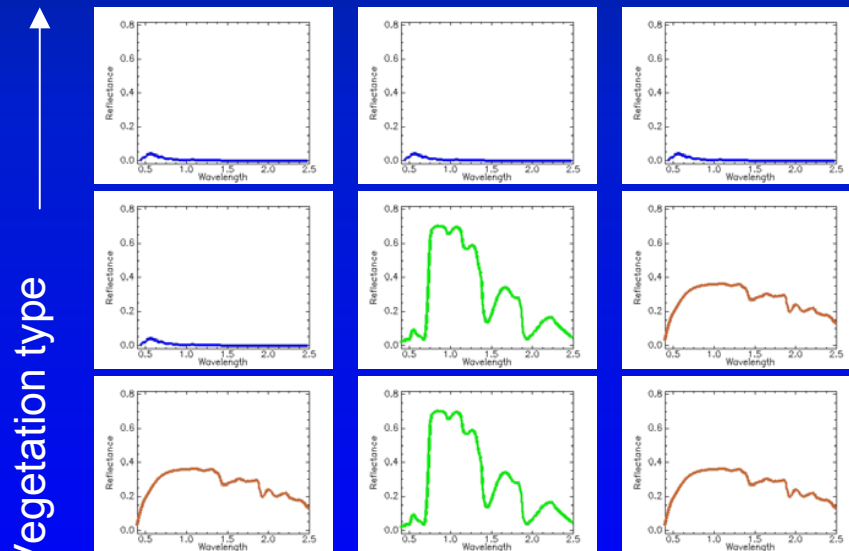
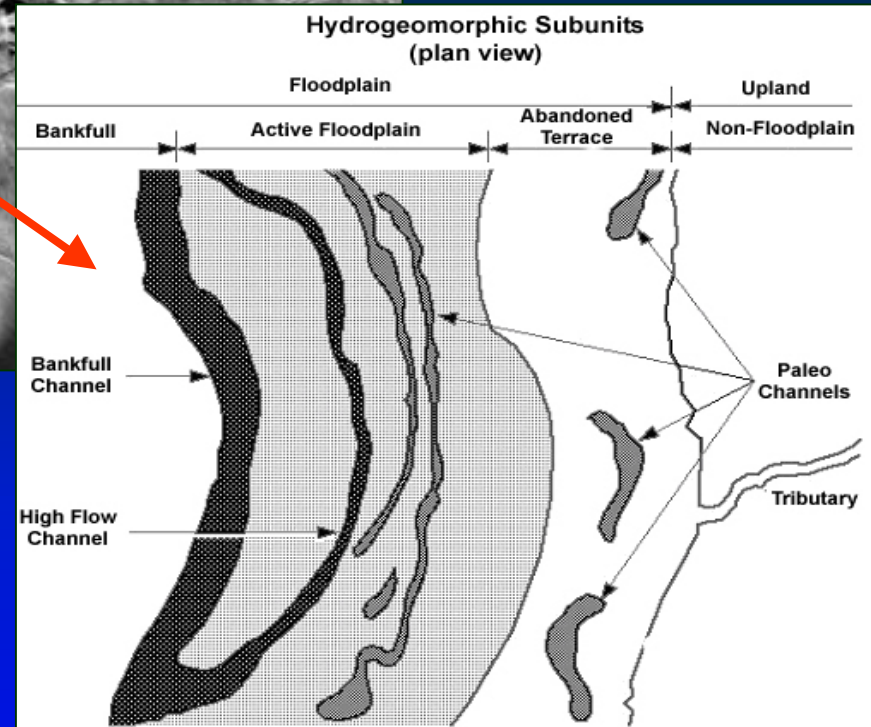
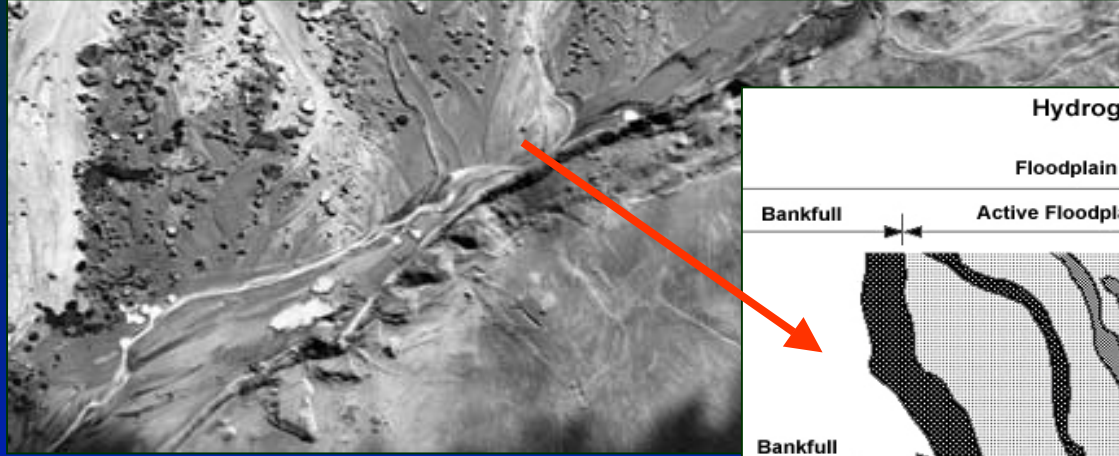


Geospatial Technologies

- Watershed mapping
- Flood inundation and impact analysis
- Spatial models for large scale studies
- Improved floodplain delineation methods
- Object-Oriented tools for interpolation of meteorological parameters for hydrologic modeling
- Common delivery framework tools
- Optimize information content of geospatial data for EM requirements
- Delivery of Web-based multi-scale GIS products decision tools



Software tools to guide mitigation and restoration of wetlands and assist in ecosystem management

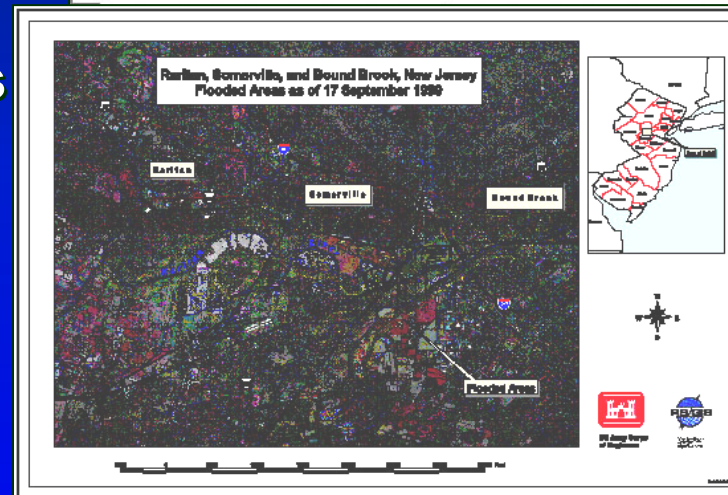
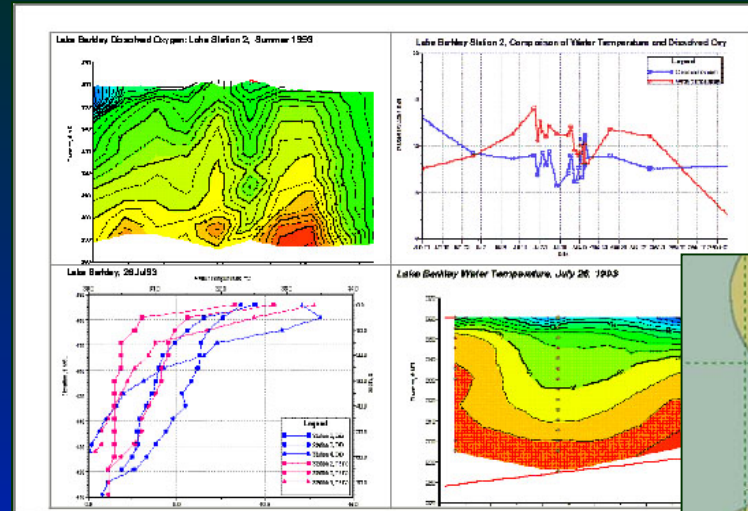


Season

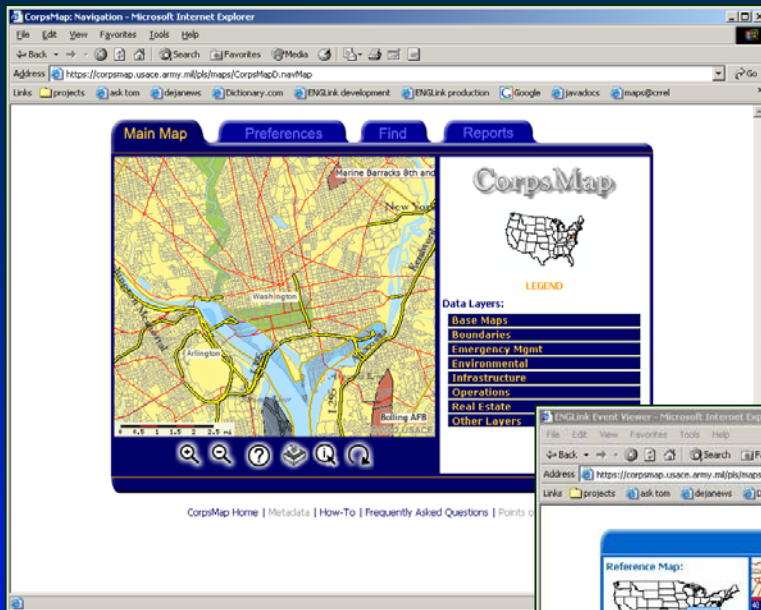
Spectral-Temporal Signatures

GIS Support to Navigation, Water Resources, WQ, EM

- Successful electronic charts for Navigation Pilot Projects (Atchafalaya and Lower Mississippi Rivers)
- GIS linked to water quality data (DASLER)
- Emergency management
 - Flood Impact Analysis
 - GIS support to eastern Europe
- Levee inspection tool for levee condition indices

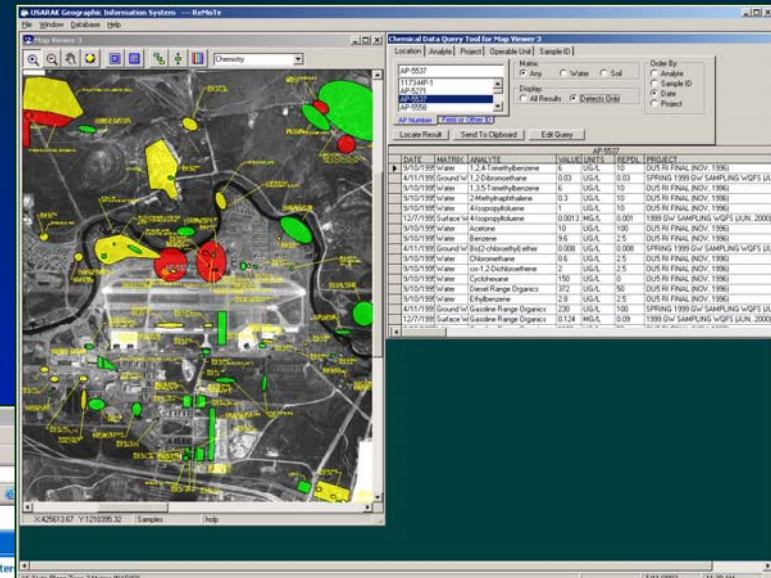
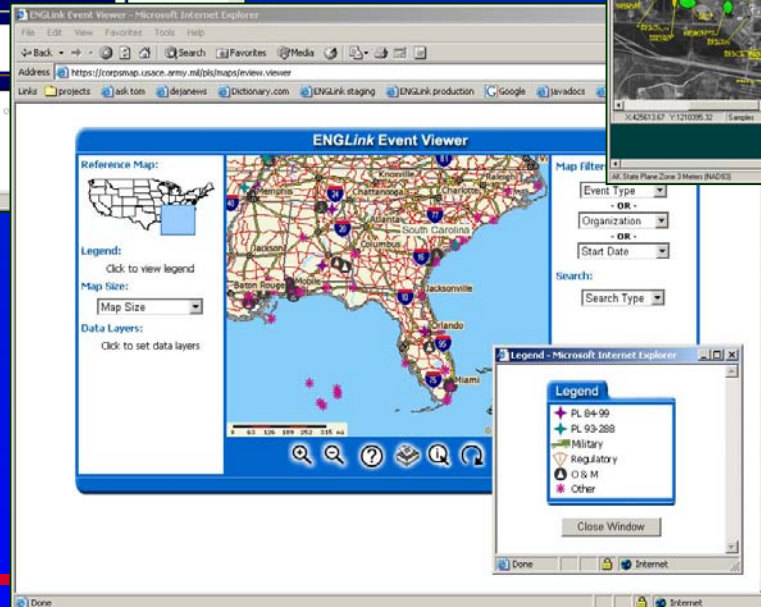


National-scale geospatial data available via web-based application for use in all Corps business areas



ENGLink

CorpsMap



ReMoTe

Future Directions

- **Hydrology & Remote Sensing**
 - HYDROS – NASA, DOD & NOAA (Cold Processes Satellite Mission) launch 2007
 - Hydroclimatology soil moisture at 40km
 - Hydrometeorology soil moisture at 10km
 - Freeze/thaw condition at 3km
 - Cold Land Processes Experiment continues with advances in assessment of snow and ground state
- **River Ice**
 - Advance numerical modeling in FE & DE
 - Virtual river ice database & modeling capabilities
 - Artificial intelligence methods to predict river ice
- **GIS**
 - Object – oriented modeling
 - Open source codes in addition to ESRI
 - Rapid mapping

Summary

- National leader in cold regions engineering for winter riverine conditions
- National leader in snowmelt modeling
- CW Center of Expertise for Remote Sensing and GIS